

Plumbing

To Maintain Verticality of New Structures

To Check Verticality of Existing Structures

Plumbing Instruments

- Plumb Bob.
- Spirit Level.
- Optical Plummet.
- Theodolite.
- Laser.

Plumb bob

The advantages.

- Cheap & simple to use.
- Supremely accurate.
- Never goes out of adjustment.

Plumb Bob

The disadvantages.

- Susceptible to wind pressure.
- Can be affected by magnetic fields.

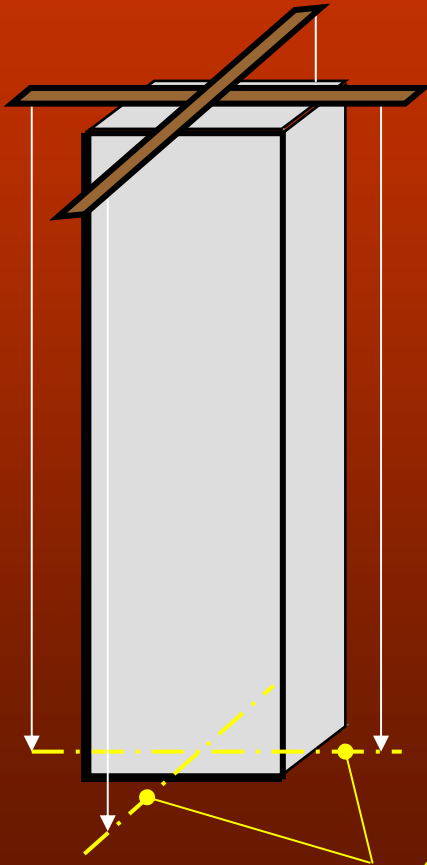
Plumb a Column Shutter

How to plumb a Column Shutter

Nail 2 battens to top of shutter box on the centre lines.

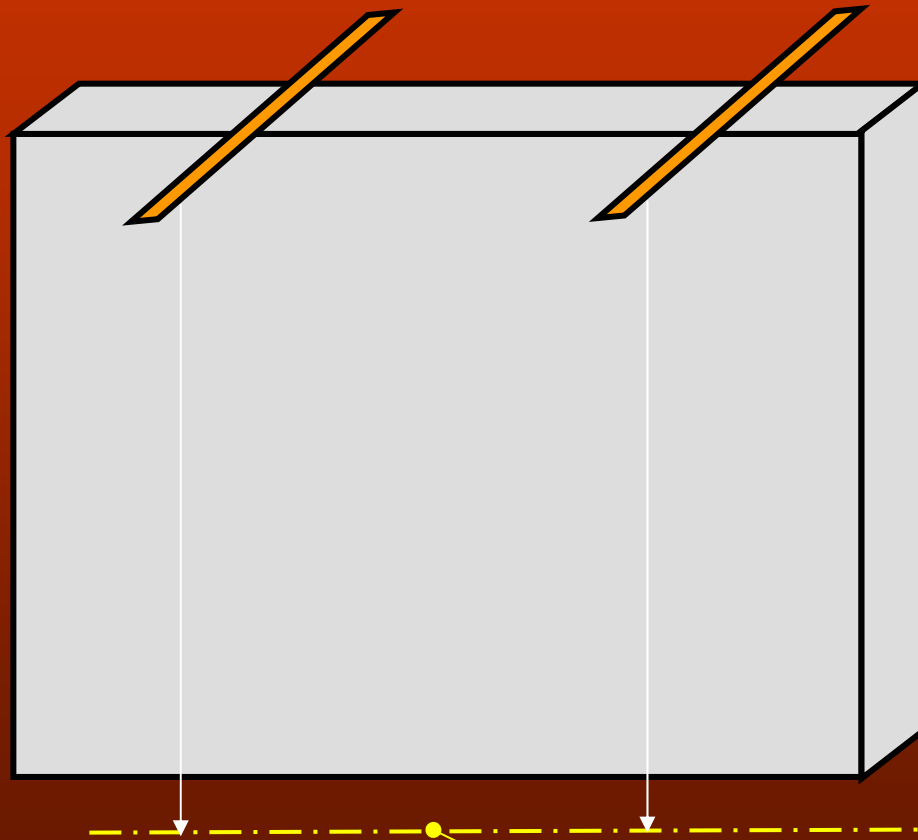
Hang plumb bobs down to floor.

Move top of shutter box to position plumb bobs on the floor centre lines.



Column centre lines

Plumb a Wall Shutter



The procedure is as before, but the reference should be an offset to the wall face, (say 300mm.)

Offset line to wall face

Spirit Level

- Can be used to check verticality for heights up to 3 metres.
- Accuracy up to $1/2500$.
- Calibration can be checked by 180° rotation.

Optical Plummet

- Accuracy from 1/2,500 to 1/200,000.
- Can be used up to 150 metres.
- Two persons are required.
- Line of sight not affected by wind.
- All surveying instruments are affected by vibration.

Optical Plummet

The instrument is set over a ground mark.

Plumbing is vertically upwards.

The line of sight must be checked at 0° , 90° , 180° , and 270° .

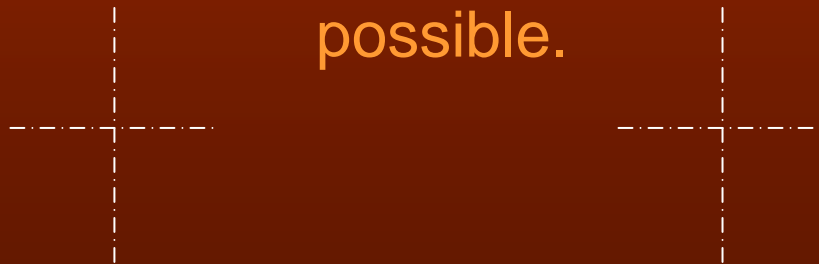


High Rise Plumb Points



Four plumb points
in basement slab.

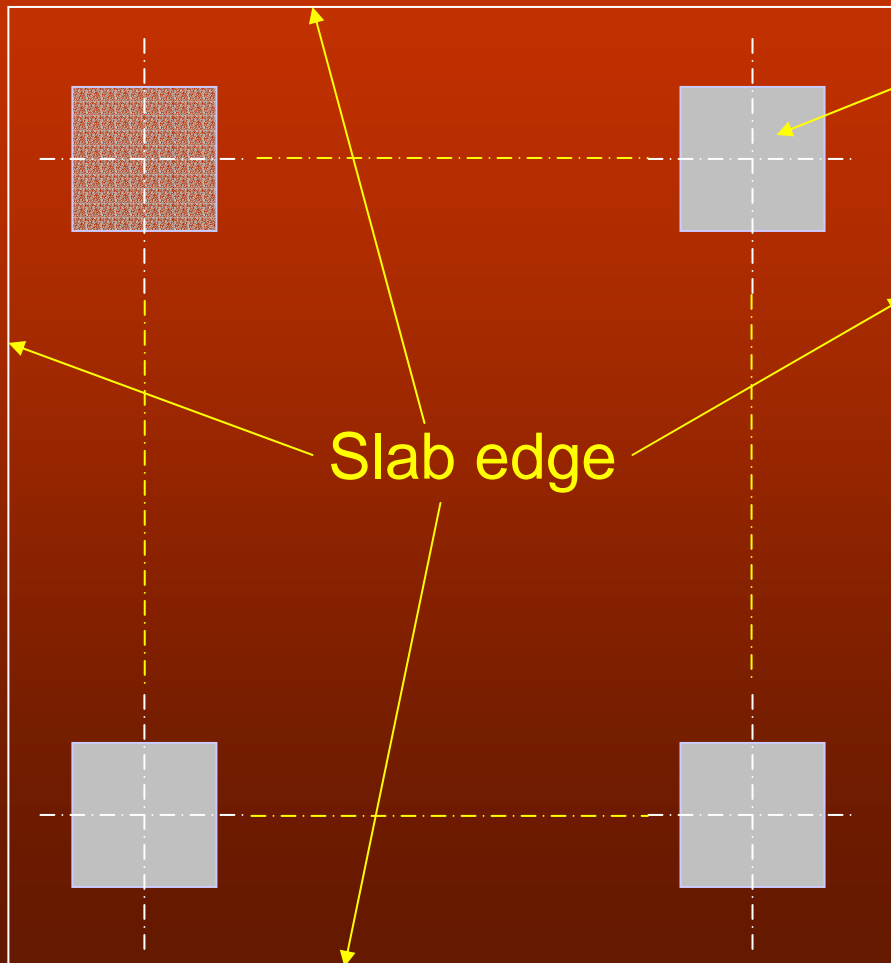
All equidistant
from slab edges if
possible.



Plumb points must be
verified independently
before use.

Their positions must be
chosen to enable
intervisibility on all floors.

High Rise Plumb Points



- Plumb up all 4 points from the basement to Perspex sheets placed over the plumbing holes.
- Measure all angles and distances between points.
- If no errors, paint lines as shown.
- Repeat for each floor plumbing only from the basement.

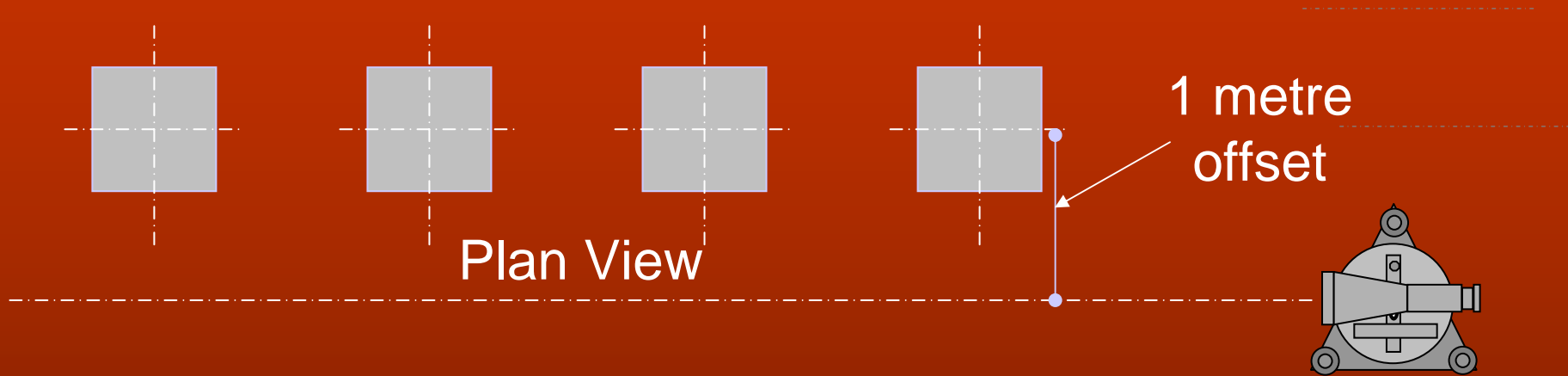
Health Safety & Security

- Your equipment must not cause an obstruction.
- You must not put yourself or others in danger.
- Do not set up over loose materials or cables.
- Do not carry an instrument on a tripod.
- Keep all accessories within arms length.
- Do not leave equipment unattended.

Theodolite

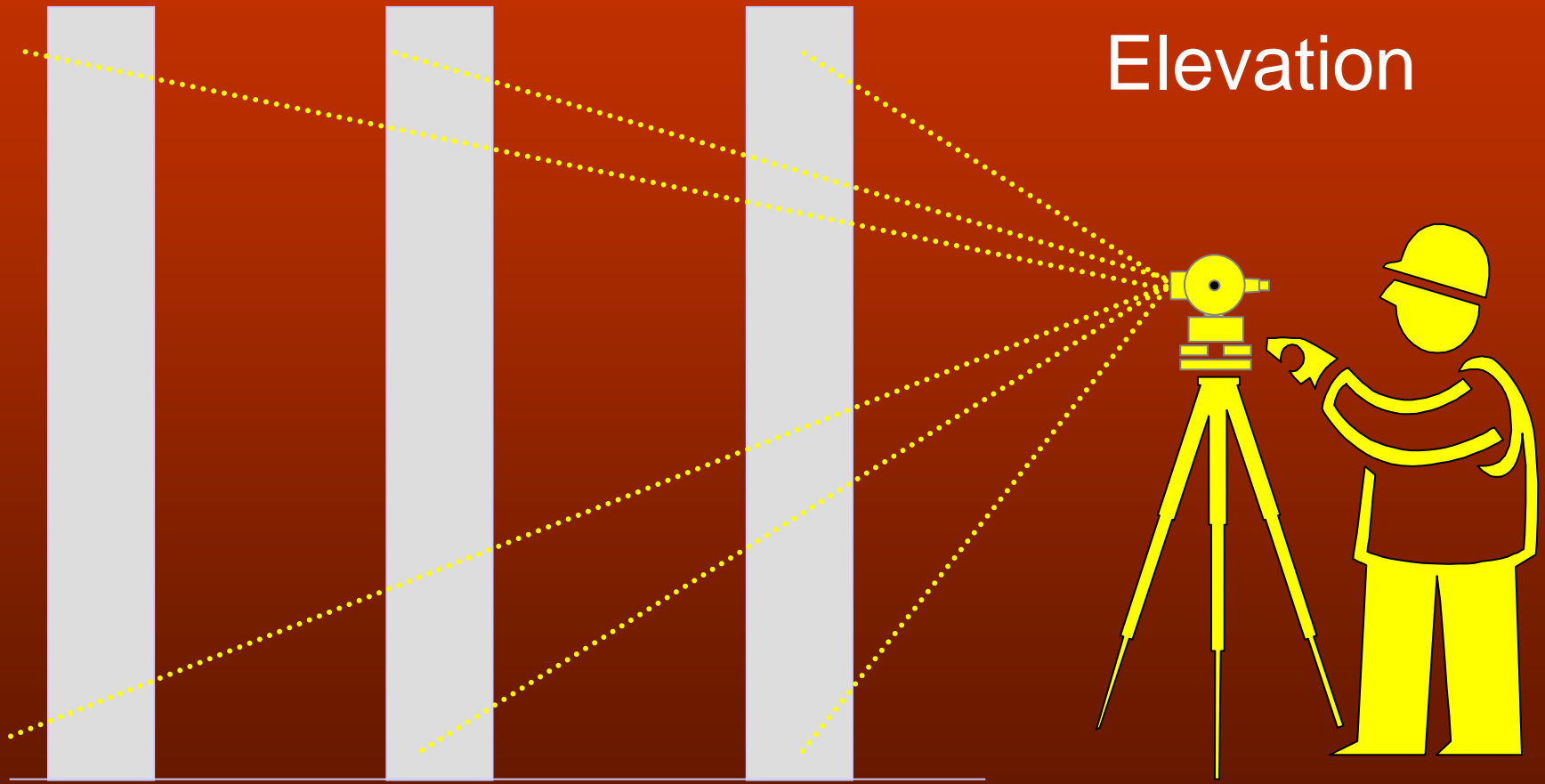
- Can be used to define a vertical line but,
- The procedure is involved and error prone.
- The more usual application is to define a vertical plane.
- Two people are required.
- The operator must be aware of the limitations of a theodolite if steep angles are involved.

Plumb a line of columns



- The column centre lines are marked on the slab before the columns are built.
- Set the theodolite on a 1 metre offset to the column centre lines.
- Measure from the tops and bottoms of all the columns to the line of sight. All the measurements should be 1 metre.

Plumb a line of columns

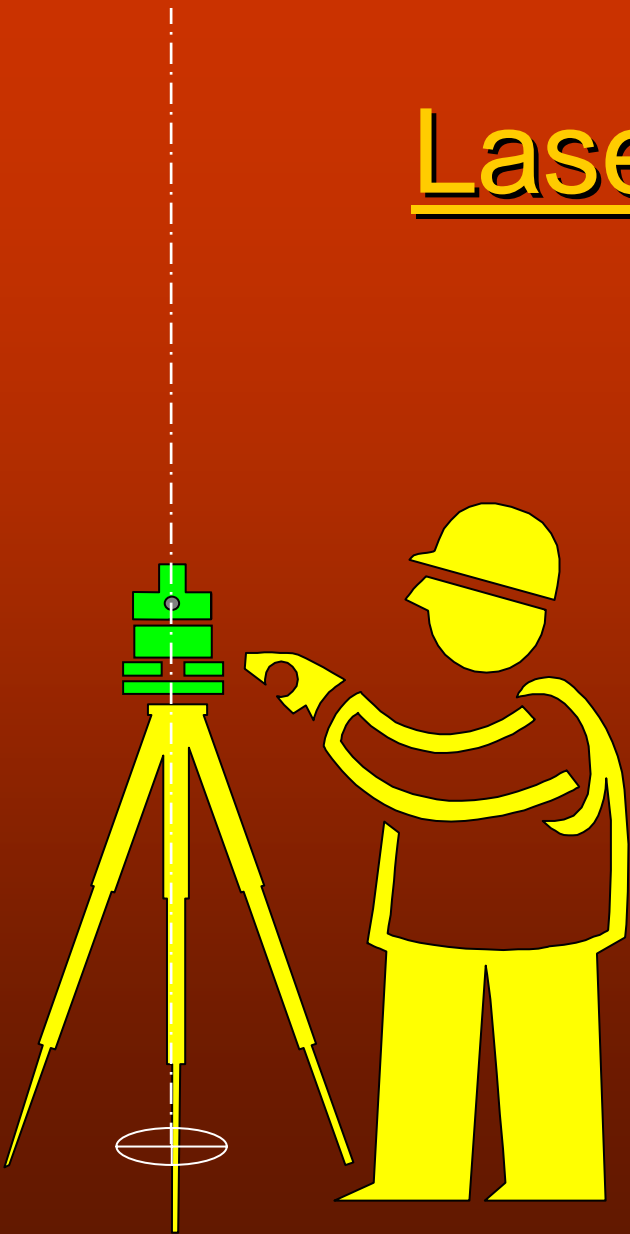


Plumb a line of Columns

- Obviously this only checks the columns in one direction.
- The theodolite must be moved to check the other direction at 90° .
- Avoid steep vertical angles, (more than 45°).

Laser Plumb Line

- Set up over a ground mark.
- Plumbing is vertically upwards.
- The beam position must be checked at 0, 90, 180, and 270 degrees.



Health Safety & Security

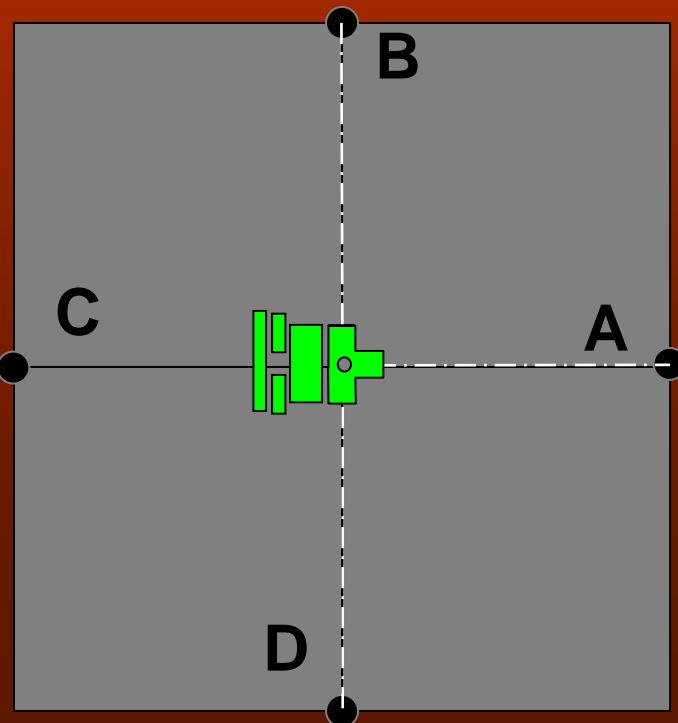
- Lasers for construction sites are intrinsically safe.
- However,
- Do not look into the beam.
- Shield the beam from passers-by.
- Beware of reflections from glass.
- These precautions apply to invisible lasers as well as visible ones.

Health Safety & Security

- The laser is a one-person instrument that is designed to be left unattended.
- Ensure that it is protected from accidental damage.
- Ensure that it is protected from theft.

Laser Plumb Plane

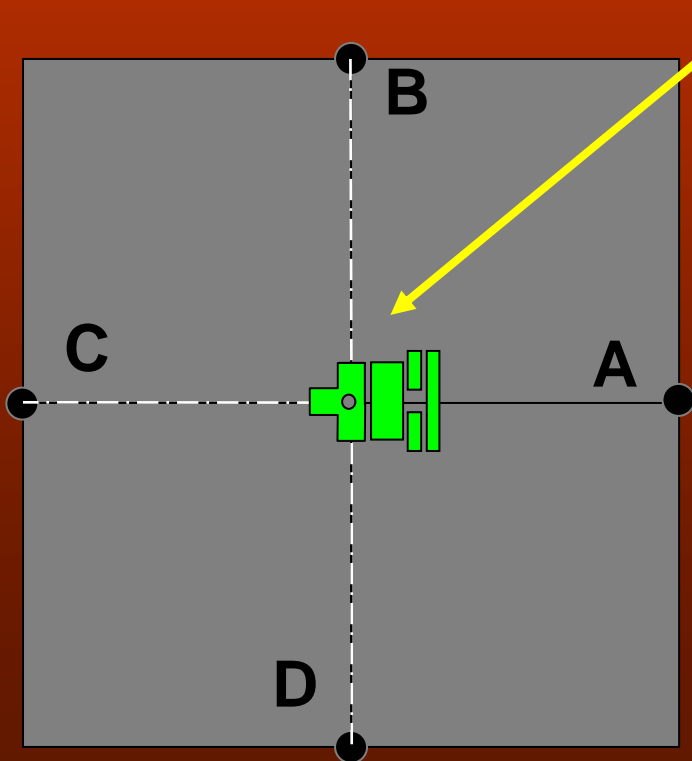
To provide a plumb plane the laser is mounted on its side in a special bracket. It is positioned on a point, (in this case a lift shaft centre line), and levelled.



The stationary beam is aligned with A, and the rotating beam describes a plumb plane through B and D, at 90° to A.

Laser Plumb Plane

To check that the beam is plumb, rotate the laser 180° while still on the same point.



Rotate the laser about the same point to the 90° and 270° positions to mark out the other plumb plane.

Other plumbing Methods

- There are other methods and other equipment used for plumbing.
- Procedures depend on available equipment and accessibility of the features to be observed.

THE END

Slide 3.

- Plumb bobs are used in mine shafts to depths of 4000 metres.
- There is no other method of transferring a point with sufficient accuracy.

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- If the plumb bob and line are non-ferrous, magnetic attraction does not apply.

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- This is a single storey height R.C. column.
- The column centre lines are always marked on the floor before the column is started.
- The column kicker is then constructed to the centre lines.
- The reinforcement is then installed.
- The shutter box is then fitted around the kicker and plumbed.
- After pouring, and before the concrete sets, the plumb is checked and corrections made if required

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- The offset line distance needs to be as small as possible, but sufficient to clear the shutter support.

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- There are various models available, of varying accuracy.
- In the simple, cheap ones, the verticality is controlled by bubbles.
- In the more accurate ones, verticality is controlled by a pendulum device called a compensator, (as used in an automatic level).
- The accurate part of the plummet is almost always upwards, rarely downwards.

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- One person operates the instrument.
- A second person holds the target.

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- You must not plumb from floor to floor.

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- The error in the horizontal angle of a theodolite due to an out-of-level transit axis is proportional to the tangent of the vertical angle.
- There is normally no problem up to 45 degrees, whose tangent is 1. However, tangents increase rapidly above 45 degrees, reaching a maximum of infinity at 90 degrees.

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- Moving the theodolite to check multiple lines of columns is tedious & time-consuming.
- If the columns were only one storey height it would be easier to use a plumb bob, or small optical plummet, to plumb each column individually.

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- Clear the area of rubbish.
- Set out the centre lines or grid lines required.
- Proceed as above.

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- If the beams do not coincide, the mean position is the true plumb line.

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- Sometimes it is not possible to have access to tall structures for measuring purposes.
- In such cases indirect methods have to be used.